surface. Such maps did not exist. A fragment here and there, to be sure, existed —a fringe of sea and lake coast; but these constituted only a bare beginning. Accordingly, in 1882 authority was given and the beginning of the mighty task of making a topographic map of the United States was begun. That work has for sixteen years progressed without interruption, and to-day we have contour topographic maps covering more than 600,000 square miles. In almost every State and Territory in the Union work has been done, while Massachusetts, Connecticut, Rhode Island, New Jersey and the District of Columbia are completely mapped.

That the prosecution of this work and the distribution of the maps has profoundly influenced interest in and knowledge of geography in the United States goes without saying. These maps are in the hands of engineers, of projectors of improvements, of teachers, of text-book makers, and of geographic students everywhere. The standards of school geographies have risen, methods of geographic teaching have been changed, and a better understanding of the relations of environment produced.

And thus the first century of progress in geography ends with a rate of progress, both in research and teaching, never surpassed. That which has been already accomplished is great; yet it is but a small part of that which remains to be done.

MARCUS BAKER.

U. S. GEOLOGICAL SURVEY.

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*ON THE INHERITANCE OF THE CEPHALIC INDEX.**

(1) THE cephalic index, when used to test any theory of heredity, possesses many merits, and at the same time one or two defects. In the first place it is supposed to be a marked racial character, and, therefore, might be considered to be strongly inherited. In the next place it remains sensibly constant after two years of age; thus the strength of inheritance can be ascertained by measurements on young children, whose parents are more frequently alive than if we have to wait for measurement till the offspring are of adult age. Further, although the cephalic index requires a more trained hand to measure it than some other measurements on the living subject, the trained observer will always deduce sensibly the same results;* on the other hand, stature measurements vary sensibly with the hour of the day and with the observer. The need of a moderately trained observer is the chief defect of cephalic index measurements; it hinders the rapid collection of numerous family measurements; the difficulty, further, of satisfactorily measuring the female head without some derangement of the toilet is a further hindrance.† The merits of the cephalic index, however, as a test of heredity far surpass its demerits. A well-organized measurement of the cephalic index in pairs of relatives would probably give the best results available for the laws of inheritance. The cephalic index measured on the living head is, of course, not so satisfactory as that measured on the skull, but the latter may be considered, even with the aid of Röntgen rays, as at present quite out of the question. The following paper has been worked out, not on very good material or on material collected with the present end in view, but on the only material that seemed at present available. It suffices

* 'Mathematical Contributions to the Theory of Evolution.' By Miss Cicely D. Fawcett, B.Sc., and Professor Karl Pearson, M.A., F.R.S., University College, London. Read before the Royal Society, February 17, 1898.

* This has been tested by frequent measurements of the same heads.

† The recent establishment of an anthropometric laboratory at Newnham College will, it may be hoped, remove the difficulty about head measurements on female students felt by the Cambridge Anthropmetric Committee.

to justify the view that the inheritance of the cephalic index offers a most satisfactory method of testing the laws of heredity.

(2) Owing to the kindness of Mr. Francis Galton, the Department of Applied Mathematics in University College, London, was placed in communication with Dr. Franz Boas, of the American Museum of Natural History, who is well known for his elaborate system of measurements on North American Indians. With extreme kindness, Dr. Boas* at once forwarded to England upwards of 1,000 sheets of measurements on comparable Indian tribes. These tribes, however, contain extremely mixed blood. In the fewest cases were pure Indian ancestors noted; one of the grandparents at least exhibited, as a rule, European blood —English, Dutch, French, Irish, etc. Dr. Boas himself writes:

"I could not give you any series that was sufficiently extensive and embraced pure Indians only, because among these tribes the determination of relationships offers peculiar difficulties. I am afraid that your results may also bring out the looseness of family relations. I should not be surprised if the relation between father and child were much lower than that between mother and child, because often another person is actually the father of the child."

Dr. Boas's last surmise is amply verified; it will be found from the table below that the coefficient of heredity between father and son is abnormally small, while that between father and daughter is actually less than the probable error of this series of measurements! If we put upon one side any purely hypothetical supposition that illegitimate births are more likely to be female than male there would seem reason to suppose some native custom by which it is held less discreditable to pass off a daughter than a son upon the titular husband. It may be asked whether, if the racial mixture is so great and the paternity so obscure, it was worth while to undertake the lengthy arithmetic* required to determine the heredity correlations. The answer is threefold: (*a*) if Galton's law of ancestral heredity be correct, inheritance is not a racial character, but a general law of living forms, and racial mixtures will not influence the result; (*b*) the results show that obscure paternity does not prevent good values being found for other relationships; in fact, the fulfilment of Dr. Boas's surmise is in itself not without value, as showing how well our algebraic theory fits itself to the facts; it might almost be said to provide a scientific measure of the conjugal fidelity of a race; (*c*) it is always worth while to undertake an investigation on the best material available, even if it be poor material for this purpose, for it emphasizes the need of new and more elaborate observations.

(3) It will be seen from the table that it has only been possible to determine the coefficient of heredity for small series, varying from 80 to 143 pairs of the seven relationships, four corresponding to the first degree of direct kinship and three to the first degree of collateral kinship. The probable errors are, as might be expected from such small series, large. Putting aside the paternal relationship, we are justified in drawing certain general conclusions, which may be thus summed up:

(*a*) The coefficients of heredity, as dedetermined from the cephalic index, differ in all cases from those determined for stature by less than their probable error and, therefore, by less than the probable error of their difference. The stature coefficients were obtained for the English

* It is difficult to sufficiently emphasize the disinterested service to science of men who do not 'monopolize' their anthropometric measurements.

* We have to thank Mr. Leslie Bramley Moore for much aid in extracting the head measurements from the slips and calculating cephalic indices.

middle classes.* We thus conclude that these results confirm Galton's law in so far as they tend to show that the strength of *inheritance is not a character of race or organ.* They do not, however, exceed the limits of errors of observation. In the case of mothers and sons the divergence is very slightly above the probable error; the ob-

INHERITANCE OF CEPHALIC INDEX—TABLE OF VALUES.

Relation.	No.	Mean.	S. D.†	Coefficient of correlation.		
				Cephalic Index.	Stature.	Theory.
Fathers	131	80.55±0.18	3.064±0.128	[0.2245±0.0560]	0.3959 ±0.0259	0.3000
Sons	131	81.53±0.20	3.432±0.143			
Fathers	108	80.41±0.22	3 428±0.158	[0.0490±0.0647]	0.3603 ±0.0276	0.3000
Daughters	108	81.90±0.26	3.976±0.182			
Mothers	104	80.80±0.20	3.020±0.141	0.3696±0.0571	0.3018 ±0.0279	0.3000
Sons	104	81.55±0.23	3.524±0.165			
Mothers	82	80.88±0.28	3.843±0.202	0.3000±0.0603	0.2841 ±0.0292	0.3000
Daughters	82	81.53±0.31	4.143±0.218			
Brothers	139	80.57±0.19	3.652±0.136	0.3787±0.0490	0.3913 ±0.0232	0.4000
Brothers	139	81.42±0.21	3.765±0.152			
Brothers	143	81.58±0.20	3.490±0.139	0.3400±0.0499	0.3754 ±0.0170	0.4000
Sisters	143	81.38±0.20	3.588±0.143			
Sisters	80	82.10±0.27	3.636±0.194	0.4889±0.0574	0.4436 ±0.0222	0.4000
Sisters	80	81.84±0.16	4.069±0.217			

Cephalic index is clearly not more strongly inherited than stature. Its variability is also very much that of stature. It is accordingly difficult to see why it should be considered as peculiarly a racial character.

(*b*) The divergencies between the observed values for the coefficients of inheritance for the cephalic index and the theoretical values obtained on the basis of Galton's law of ancestral heredity are greater than the divergencies between the former and the coefficients for stature.‡ served and theoretical values are identical in the case of mothers and daughters; they are less than the probable error for brothers and brothers and only slightly larger than it for brothers and sisters; for sisters and sisters the divergence is about one and a-half times the probable error. The mean weighted values of the coefficients for direct and collateral kinship are 0.3366 and 0.4004, the former differing by less than half its probable error from the theoretical value 0.3000, and the latter sensibly identical with its theoretical value, 0.4000.

We conclude, therefore, that Galton's law of ancestral heredity gives values for the inheritance within the limits of the probable errors of observation. But,

(*c*) As in the case of stature there is, on

* *Phil. Trans.*, Vol. 187, A, pp. 270–281.

† S. D. = standard-deviation or 'error of mean square.'

‡ It is to be noted that, putting paternity aside, the order of relative magnitude of the coefficients of heredity is precisely the same for both cephalic index and stature.

the whole, a tendency of the coefficients for cephalic index to be somewhat greater than their values as given by Galton's law. It is, therefore, reasonable to suppose that the heredity constant γ (introduced in a paper 'On the Law of Ancestral Heredity') is not, as Mr. Galton takes it, unity, but has some slightly less value.

Other conclusions which may be drawn from the above table are:

(*d*) Among Indians of mixed blood the women are more brachycephalic and more variable than the men. This is in accordance with the general conclusion reached in a paper on 'Variation in Man and Woman,'* namely:

"The lower races give us results in sensible accordance with those we have drawn from the data for ancient civilizations, namely, the women are on the whole more brachycephalic and slightly more variable than the men."

(*e*) The younger generation is more brachycephalic and more variable than its parentage.

The whole of this difference can hardly be due to any change of shape of the skull with old age, for the majority of parents had in this case not passed the prime of life. It may be due to (i) a correlation between dolichocephaly and fertility or between dolichocephaly and philogamy, or (ii) more probably to the action of natural selection (results obtained, but not yet published, by the present writers show a correlation between physique and cephalic index), or (iii) to a greater or less admixture of white blood in the younger generation.

(*f*) Parents of sons are significantly less variable than parents of daughters. This is in accordance with the result previously obtained that mediocre fathers are likely to have sons,† but disagrees with the result for stature—based on a far smaller probability—that mediocre mothers are likely to have daughters.

The conclusions of this paper, while appearing to the writers of interest, are to be taken, in the first place, as *suggestions* for much larger series of measurements and for new lines of investigation.

* Pearson, 'The Chances of Death,' Vol. 1, p. 370.

† '*Phil. Trans.*,' Vol. 187, A, p. 274.

A COMPLETE SKELETON OF TELEOCERAS THE TRUE RHINOCEROS FROM THE UPPER MIOCENE OF KANSAS.

Together with the very full series of Upper Miocene skulls in the American Museum a complete skeleton of a rhinoceros representing an aged female of very large size, has recently been mounted. We used from materials belonging to several individuals secured by our excavations in Phillips Co., Kansas, under the direction of Dr. Wortman in the months of September, October and November, 1894.

The writer's attention was first drawn to the largely disregarded sexual and age characters of fossil Ungulates in studying the group of Titanotheres; the extinct rhinoceroses conform to the laws which were observed in that group, and which are familiar enough among living types, namely: males, of larger size with more robust and rugose skulls; horns, if present, more prominent; canines largely developed; incisors and anterior premolars disappearing in adults. By the comparison of the 16 skulls and 13 jaws, representing both sexes and all stages of growth, we are enabled for the first time to define positively the animal long known as *Aphelops fossiger*, to distinguish it both from *Rhinoceros* and *Aceratherium*, and to point out its important sexual and individual variations.

We owe to Hatcher the valuable demonstration that *Aphelops fossiger* bore a terminal horn upon the nasals, although he assigned this character to a type which he supposed represented a new species, namely,